Strategic Midwest Area Renewable Transmission (SMARTransmission) Study

WIndiana 2010

July 21, 2010

Agenda/Objectives

- **SMARTransmission**
  - Introduction
  - Project Sponsors
  - Project Contractor
  - Key Drivers
  - Overview
- **Phase One**
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  - Sensitivities
  - Alternatives Studied
  - Result – Alternatives Selected for Phase Two Analysis
- **Phase Two**

SMARTransmission

Introduction

Comprehensive study of the transmission needed in the Upper Midwest to support renewable energy development and transport that energy to consumers within the study region.

- **Objectives**
  - Develop Extra High Voltage (EHV) overlay alternatives to support Federal and State energy policies and goals.
  - Conduct reliability analysis to recommend technically sound solutions to integrate EHV transmission into the existing transmission system.
  - Conduct economic analysis of the solutions identified in the technical analysis to ascertain the benefits of EHV transmission to the study region.

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Project Sponsors

- **Electric Transmission America, LLC (ETA)**
  - American Electric Power (AEP)
  - MidAmerican Energy Holdings Company (MEHC)
- **American Transmission Company (ATC)**
- **Exelon Corporation**
- **MidAmerican Energy Company (MEC)**
- **NorthWestern Energy**
- **Xcel Energy**

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Project Contractor

- **Quanta Technology**
  - Independent consulting arm of Quanta Services
  - 70+ professional staff, with many industry-renowned experts
  - Headquarters in Raleigh, NC. Regional offices in MA and CA

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Key Drivers

- Multi-Regional Transmission Focus
- Consistent with Federal, State, and Local Energy Policies and Goals
- Technical and Economic Based Alternatives
- Project Sponsors' Steering Committee
- Open and Transparent Process
- Stakeholder Input

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Overview

- **Phase One**
  - Develop performance metrics
  - Develop alternatives
  - Perform Steady State Analysis
  - Identify top performers
- **Phase Two**
  - Develop Societal Benefits Metrics
  - Perform Security Constrained Economic Dispatch
  - Evaluate top performing alternative
  - Provide final ranking

Phase One Study

Assumptions

- **Study Time Frame**
  - 20 years into the future
  - Summer peak cases - 2029, 2024, & 2019
  - Shoulder load cases - 2029, 2024, & 2019
- **Study Area**
  - North Dakota, South Dakota, Iowa, Nebraska, Indiana, Ohio, Illinois, Minnesota, Missouri, Wisconsin and Michigan
- **Annual load growth**
  - Range from 0.85% to 1.4%

Phase One Study

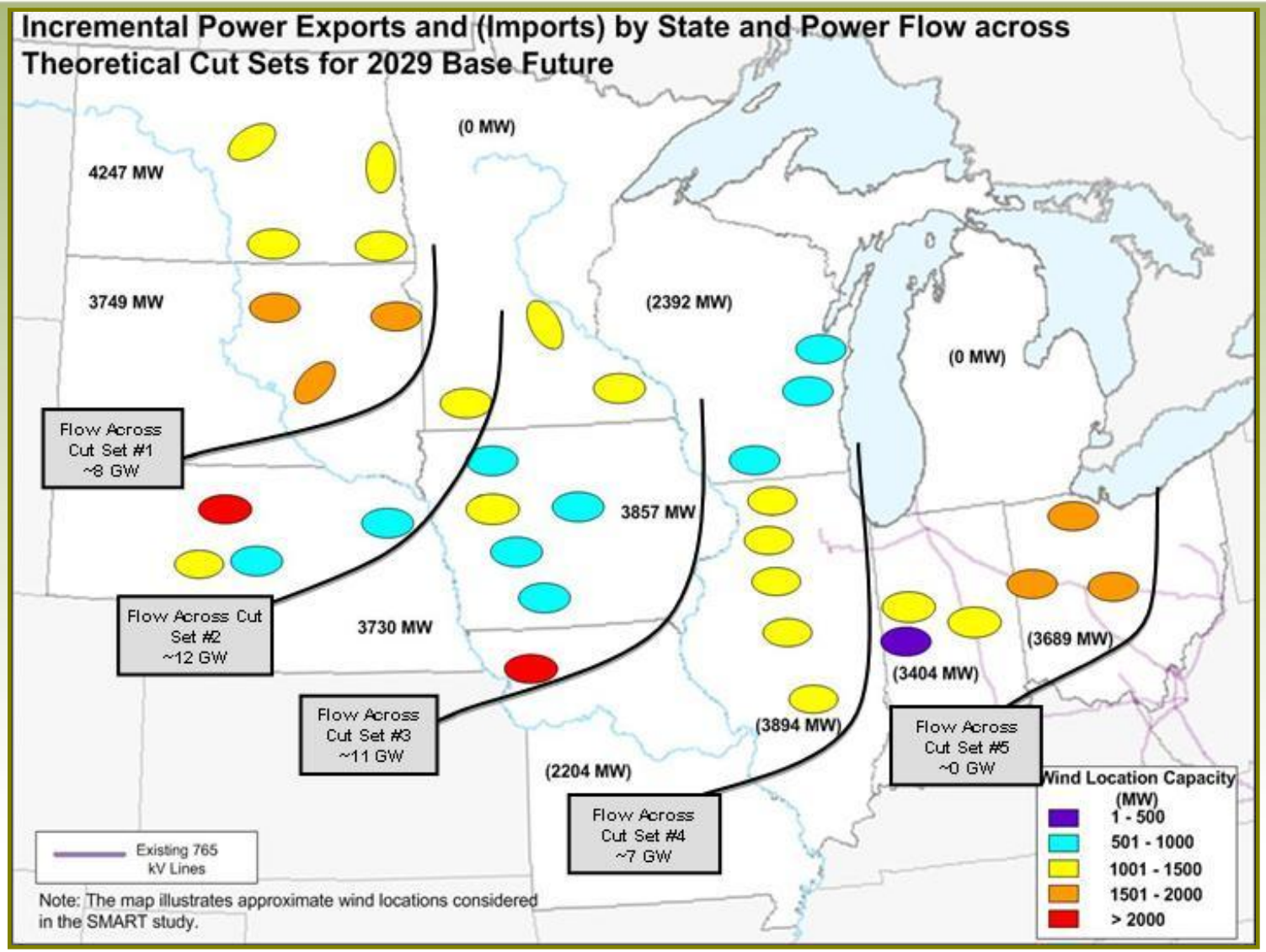
Assumptions (Continued)

- **Wind Generation**
  - Known generation in RTO/ISO queue included
  - Allocated based on Federal and State guidelines and assumptions
  - 20% contribution during on-peak hours and 90% contribution during off-peak hours
- **Non Wind Generation additions/Retirements**
  - Known generation in RTO/ISO queue included
  - Known retirements

Renewable Energy Requirement by State for Base Wind 2029 (Assumptions Continued)

	IA	IL	IN	MI	MN	MO	ND	NE	OH	SD	WI
Federal 20% - State RPS % - Utility RPS in %	20%	25%	20%	20%	28%	20%	20%	20%	25%	20%	25%
% of energy renewable from wind	80%	75%	80%	80%	80%	80%	80%	80%	50%	80%	65%
Average Capacity Factor (Based on 3 Year Capacity Factor Statistics)	0.378	0.30	0.325	0.303	0.363	0.354	0.398	0.403	0.304	0.404	0.30
Energy Growth (average US)	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.0%	1.1%
Energy Usage by US State (GWh) / 2007 EIA	45,270	146,055	109420	109,297	68,231	85,533	11,906	28,248	161,771	10,603	71,301
Total energy usage extrapolated assuming constant growth (billion GWh) (2029)	56,348	181,800	136,197	136,043	84,928	106,464	14,819	35,161	201,359	13,198	90,703
Energy Required for the RPS (GWh)	11,270	45,449	27,239	27,209	23,355	21,293	2,964	7,032	50,340	2,640	22,676
RPS energy from wind (GWh)	9,016	34,087	21,792	21,767	18,684	17,034	2,371	5,626	25,170	2,112	14,739
Total Energy Requirement	**172,397,256 MWhr**										
Total Wind (MW) by State Existing + Incremental	**6,694**	**7,919**	**3,577**	**8,201**	**5,876**	**3,070**	**4,833**	**5,196**	**4,729**	**4,208**	**2,506**
Total Base Wind included in the Study	**56,809 MW**										

Approximate Wind Locations and Theoretical Cut Sets for Power Flow



Phase One Study

Futures

- **Base Generation Future**
- **High Gas Future**
- **Low Carbon Future**

  Plant retirements – Coal plants ≥40 years old and ≤ 250MW

Phase One Study

Sensitivities

- Higher than forecasted load growth
- Lower than forecasted load growth
- High Wind capacity
- Low Wind capacity
- High wind import and export SPP

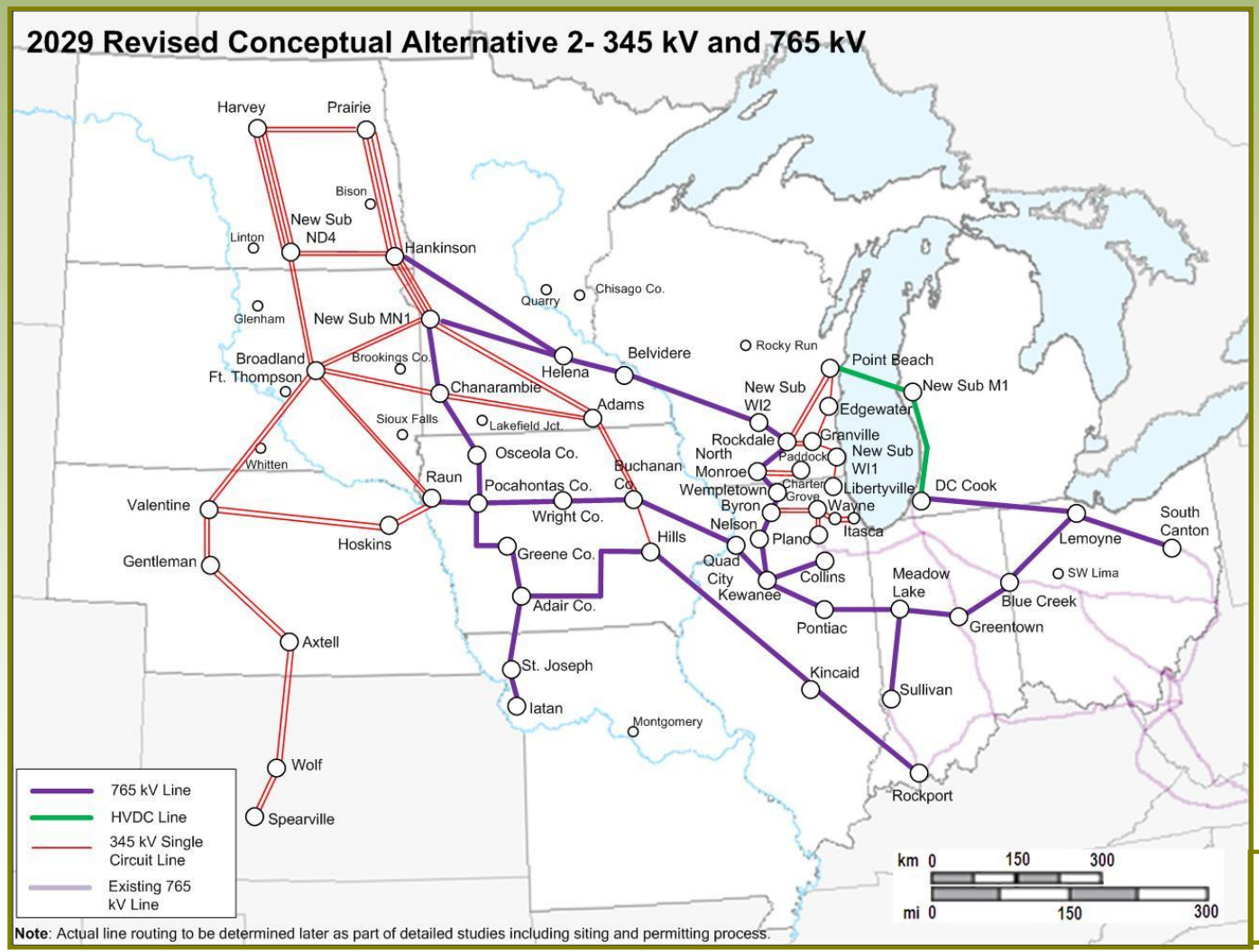
Phase One Study

Transmission Overlay Alternatives

- **Eight Conceptual Alternatives**
  - 1 – 345 kV
  - 2 – 345 kV & 765 kV
  - 5 – 765 kV
- **Simulation Models**
  - On Peak
  - Off Peak
- **Run Contingencies and Update Alternatives**
  - Generation Futures
  - Sensitivities
  - Wind Models
- **Score and Rank Alternatives**

Phase One Study

The Selected Transmission Overlay Alternatives



Alt 2

Phase One Study

The Selected Transmission Overlay Alternatives

Alt 5

Phase One Study

The Selected Transmission Overlay Alternatives

Alt 5a

Phase One Study

High Level Summary

High Level Summary	Alt 2	Alt 5	Alt 5A
Total Structure miles of 345 double circuit lines	4,409	80	80
Total Circuit miles length of 765 lines	3,950	7,773	7,066
Number of 765/345 kV Transformers	21	40	40
Number of River Crossing lines	5	8	8
HVDC Underwater Cable Circuit miles	64	91	91
HVDC Overhead Cable Circuit miles	200	0	385
Number of 345 kV new buses or connection to existing buses	34	5	5
Number of 765 kV new buses or connection to existing buses	32	46	44

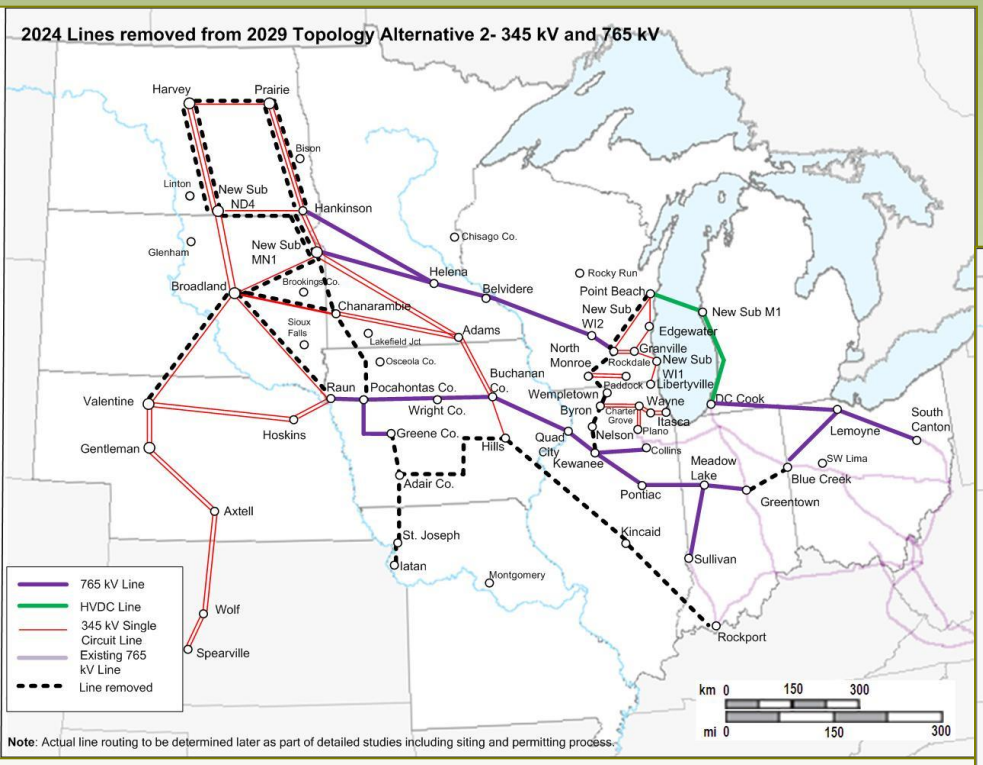
Phase one Study

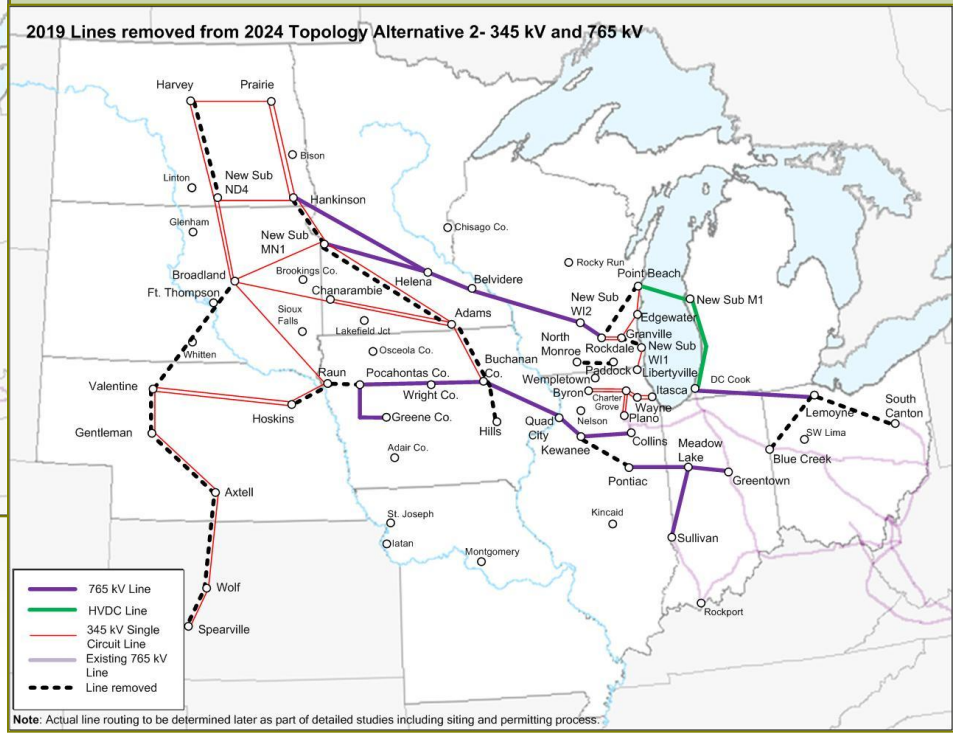
High Level Summary

Line Costs in Millions of Dollars	Alt 2	Alt 5	Alt 5A
Estimated Cost for 345 kV Lines	$9,053	$158	$158
Estimated Cost for 765 kV Lines	$10,705	$21,066	$19,149
Total Cost Transmission Lines	$19,758	$21,224	$19,307
Transformers Costs			
Estimated Cost of 765/345 kV Transformers	$445	$848	$848
Estimated Cost of 230/345 kV Transformers	$7	$7	$7
Total Costs Transformation	$452	$855	$855
Network Substation/Station Costs 345 kV	$472	$59	$59
Network Substation/Station Costs 765 kV	$552	$879	$853
Total cost	$1,024	$938	$912
River Crossing line costs	$35	$56	$56
HVDC Costs	$1,427	$1,281	$2,500
Shunt Reactors	$1,115	$1,413	$1,205
Total Estimated Costs	$23,811	$25,767	$24,835

Phase One Study

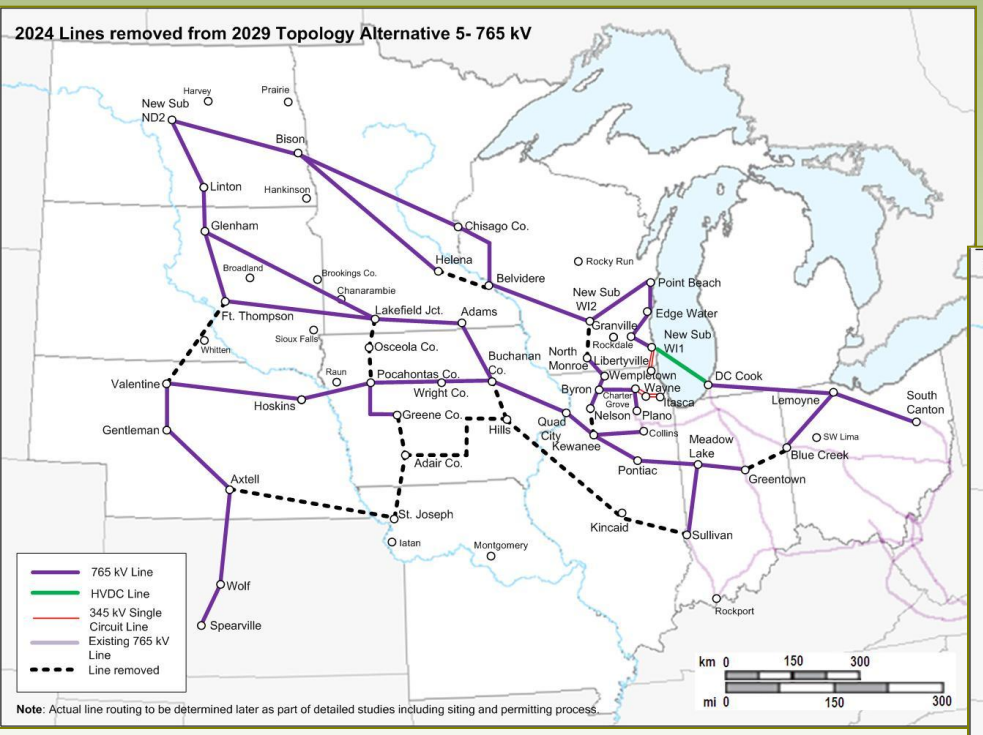
Sequencing of Alternatives (Alt 2)

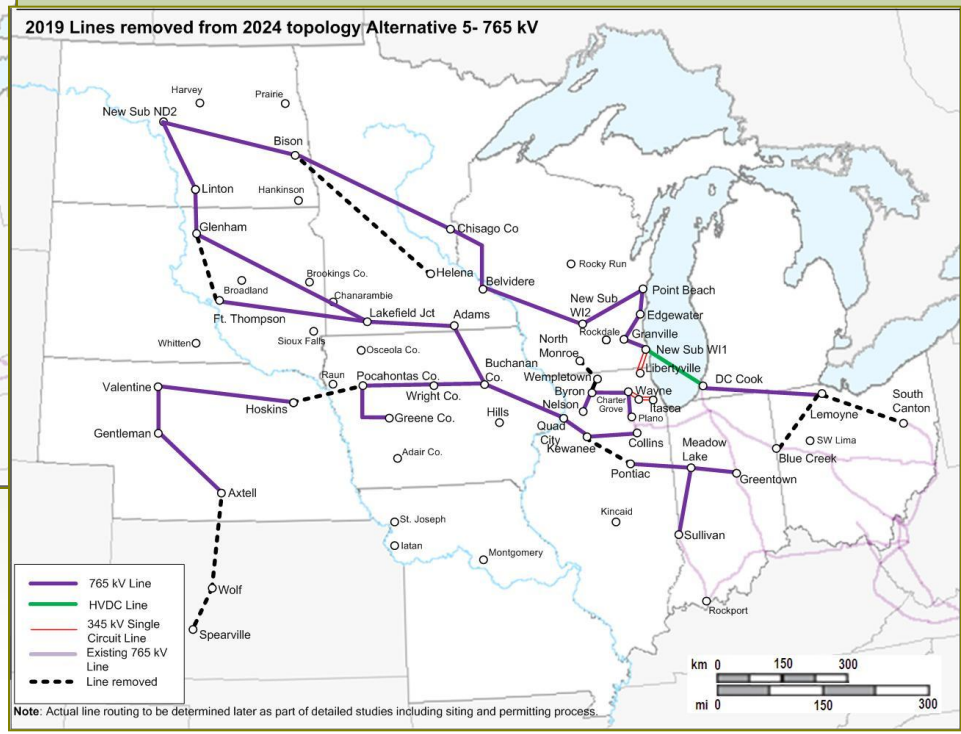




Phase One Study

Sequencing of Alternative (Alt 5)





Phase Two Study

- Societal Benefits Evaluation
  - PROMOD Analysis
  - Security Constrained Economic Dispatch
  - Develop Societal Benefits Metrics
  - Evaluate top performing alternative
  - Provide final ranking

Next Steps

- Issue the Final Report – Third Quarter 2010
- Submit the results to Midwest ISO, PJM, SPP and MAPP for their review and appropriate approvals
- Study Sponsors committed to work with RTO's/ISO's as they evaluate the plan

For Additional Information Please Refer to
WWW.SMARTSTUDY.BIZ

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